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# NiM2B

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## Frequency Programmable 25kHz NBFM Transceiver

***The narrow band NiM2B transceiver offers a low power, reliable data link in a Radiometrix transceiver standard pin out and footprint. This makes the NiM2B ideally suited to those low power applications where existing single frequency wideband UHF modules have insufficient range.***


*Figure 1: NiM2B-434.650-10*

## Features

- Conforms to ETSI EN 300 220-2 (radio) and EN 301 489-3 (EMC)
- Standard frequency - 434.650MHz (programs to any frequency in the 432 - 436MHz range)
- 458MHz (UK) and 448MHz band units are also available.
- Data rates up to 10kbps
- Usable range over 500m
- 12.5kHz / 20kHz / 25kHz Channel spacing (factory set)
- Feature-rich interface (true analogue and/or digital baseband)

Available for licence-exempt operation in the 433MHz EU band, the NiM2B modules combine effective screening with internal filtering to minimise spurious radiation and susceptibility thereby ensuring EMC compliance. They can be used in existing low data rate (<10kbps) applications where the operating range of the system using wide band transceivers need to be extended. Because of their small size and low power consumption, NiM2B is ideal for use in battery-powered portable applications.
NiM2B is also available as separate NiM2BT transmitter and NiM2BR receiver, which can be used as dual-in-line equivalents of NTX2B transmitter and NRX2B receiver respectively.

## Applications

- EPOS equipment, barcode scanners
- Data loggers
- Industrial telemetry and telecommand
- In-building environmental monitoring and control
- High-end security and fire alarms
- DGPS systems
- Vehicle data up/download

## Technical Summary

- Fully integrated sigma-delta PLL synthesizer based design
- High stability TCXO reference
- Data bit rate: 10kbps max.
- Transmit power: +10dBm (10mW)
- SAW front-end band pass filter, image rejection: >60dB
- Receiver sensitivity: -118dBm (for 12dB SINAD)
- RSSI output with >50dBm range
- Supply: 3.1V - 15V @ 20mA transmit, 18mA receive
- Dimensions: 33 x 23 x 11mm (fully screened)

**Evaluation platforms**: NBEK + BiM / SMX carrier

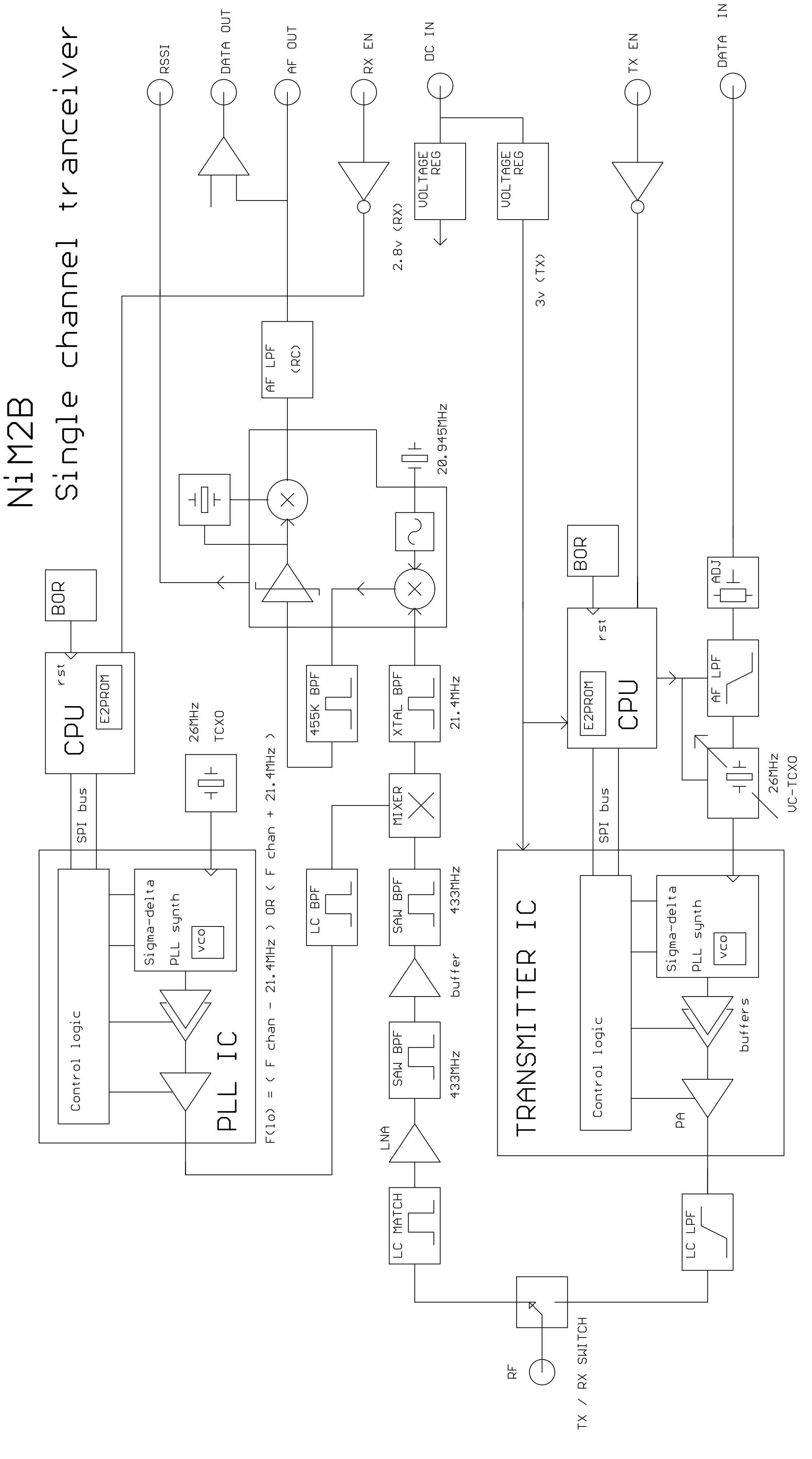


*Figure 2: NiM2B-434.650-10*

## Functional description

The transmit section of the NiM2B consists of a highly integrated sigma delta (fractional N) synthesizer based single chip RF device, configured over an SPI serial bus by an on-board microcontroller. The primary frequency reference for the transmitter is a 26MHz VC-TCXO. Modulation is applied directly to this reference via an AF baseband filter (rather than using the chip's internal modulator) to permit a wider range of baseband data rates and waveforms. Operation is controlled by the N_TXE line, the transmitter achieving full RF output typically within 5ms of this line being pulled low. The RF output is filtered to ensure compliance with the appropriate radio regulations and fed to the 50Ω antenna pin.

The receiver section of the NiM2B consists of a highly integrated sigma delta (fractional N) synthesizer based Local Oscillator (LO), configured over an SPI serial bus by an on-board microcontroller. The primary frequency reference for the LO is a 26MHz VC-TCXO. The RF input is filtered using SAW filters in the front-end to provide image rejection and enhanced blocking performance. These SAW filters reduce user programmable frequency range to the filter passband, but a wide number of (factory set) sub-bands are available, determined by SAW filter availability.

## User interface

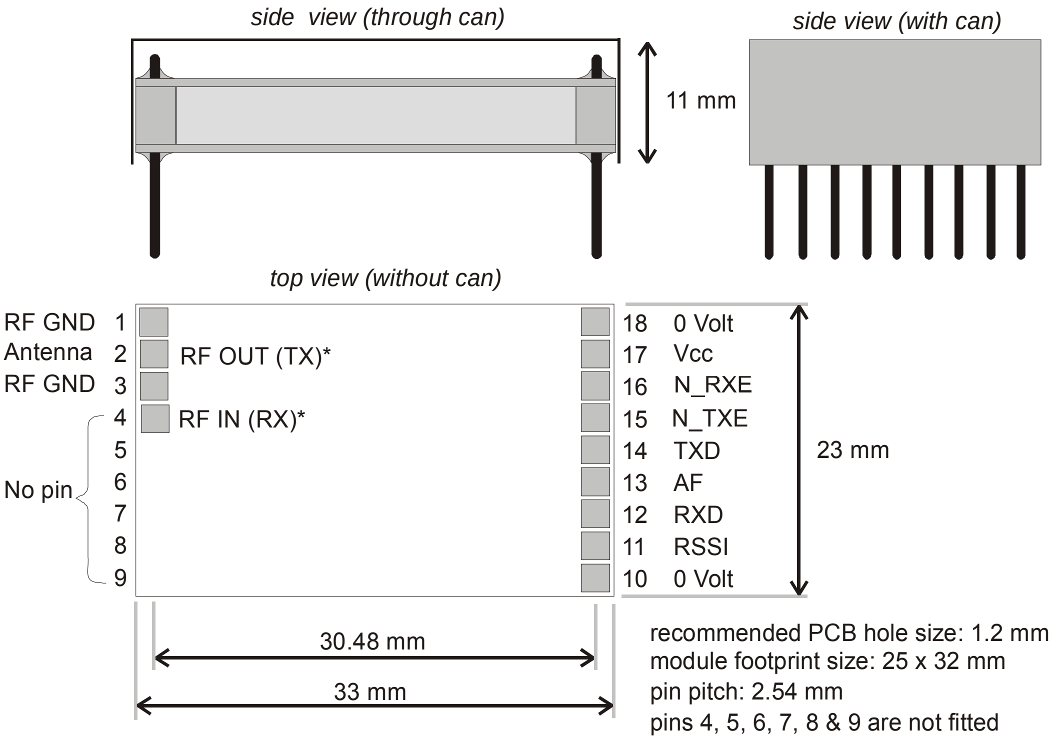


*Figure 3: NiM2B pin-out and dimension*

| NiM2B Pin | Name | Function |
|---|---|---|
| 1, 3, 10, 18 | 0V | Ground |
| 17 | VCC | 3.1 – 15V DC power supply |
| 16 | N_RXE / RX PGM | Pull low to enable Receiver / receive programming in put |
| 15 | N_TXE / TX PGM | Pull low to enable Transmitter / transmit programming in put |
| 14 | TXD | DC coupled input for 3V CMOS logic. $R_{in}$ = 100kΩ |
| 13 | AF | 500mV $_{pk\text{-}pk}$ audio. DC coupled, approx 1.5V bias |
| 12 | RXD | Open collector output, with a 10kΩ pullup to Vcc. Suitable for Biphase codes |
| 11 | RSSI | DC level between 0.5V and 2V. 60dB dynamic range |

***NOTES**:*

1. *N_Rxe and N_Txe have (10K approx.) pullups to +Vin*
2. *Unit is programmable (in the same way as an NTX2B or NRX2B) using the N_Rxe or N_Txe pins Reprogramming requires a 0v to +Vin logic level non-inverted RS232 data-stream to pin 3 or 4 An RS232 port can be directly connected to the enable pin for programming*
3. *Avoid N_Rxe and N_Txe both low: undefined module operation (but damage will not result)*
4. *A 25mW version is available (3.4-15v operation, 40mA TX)*
5. *Pinout is as NiM2. On RF connector end only pins 1,2,3 are present (*except for NiM2B with separate RX and TX ports which has 4 pins. See ordering info ( p10) for further details on this special built).*
6. *Switching time as controlled by N_Txe or N_Rxe pins is <5mS, but when power is first applied to the unit there is a 20mS long "calibration" period before the transmitter becomes active. If the rail is switched (as opposed to the EN pin) then this should be considered as a 25mS device*

### *Absolute maximum ratings*

*Exceeding the values given below may cause permanent damage to the module.*

| | |
|---|---|
| Operating temperature | -20°C to +70°C |
| Storage temperature | -30°C to +85°C |
| | |
| RF in (pin 1) | ±50V @ <10MHz, +13dBm @ >10MHz |
| All other pins | -0.3V to +15.0V |

## *Performance specifications:*

*(Vcc = 3.1V / temperature = 20°C unless stated)*

| General | pin | min. | typ. | max. | units | notes |
|---|---|---|---|---|---|---|
| *DC supply* | | | | | | |
| Supply voltage | 17 | 3.1 | - | 15 | V | |
| TX Supply current (10mW) | 17 | | 20 | | mA | |
| RX Supply current | 17 | | 18 | | mA | |
| | | | | | | |
| Antenna pin impedance | 2 | | 50 | | Ω | |
| RF centre frequency | | | 434.650 | | MHz | 1 |
| Channel spacing | | | 25 | | kHz | |
| Number of channels | | | 1 | | | 1 |
| | | | | | | |
| ***Transmitter*** | | | | | | |
| ***RF*** | | | | | | |
| RF power output | 2 | +9 | +10 | +11 | dBm | 2 |
| Spurious emissions | 2 | | | -40 | dBm | 3 |
| Adjacent channel TX power | | | -37 | | dBm | |
| Frequency accuracy | | | ±1.5 (2.5ppm) | | kHz | 4 |
| FM deviation (peak) | | ±2.5 | ±3.0 | ±3.5 | kHz | 5 |
| | | | | | | |
| ***Baseband*** | | | | | | |
| Modulation bandwidth @ -3dB | | 0 | | 5 | kHz | |
| TXD input level (logic low) | 14 | | 0 | | V | 6 |
| TXD input level (logic high) | 14 | | 3.0 | | V | 6 |
| | | | | | | |
| ***Dynamic timing*** | | | | | | |
| TX select to full RF | | | | 5 | ms | |
| | | | | | | |
| ***Receiver*** | | | | | | |
| ***RF/IF*** | | | | | | |
| RF sensitivity @ 12dB SINAD | 2, 13 | | -118 | | dBm | |
| RF sensitivity @ 1ppm BER | 2, 12 | | -112 | | dBm | |
| RSSI range | 2, 11 | 50 | 60 | | dB | 7 |
| Blocking | 2 | | 80 | | dB | |
| Image rejection | 2 | 60 | | | dB | |
| Adjacent channel rejection | 2 | | 60 | | dB | 3 |
| Spurious response rejection | 2 | 60 | | | dB | |
| LO leakage, radiated | | | -60 | | dBm | 4 |
| | | | | | | |
| ***Baseband*** | | | | | | |
| Baseband bandwidth @ -3dB | 13 | | 5 | | kHz | |
| AF level | 13 | | 500 | | $mV_{P-P}$ | 8 |
| DC offset on AF out | 13 | | 1.5 | | V | |
| Distortion on recovered AF | 12 | | | 5 | % | |

| General | pin | min. | typ. | max. | units | notes |
|---|---|---|---|---|---|---|
| ***Dynamic timing*** | | | | | | |
| *RX enable with signal present* | | | | | | |
| N_RXE active (low) to stable AF output | 16, 13 | | 10 | | | |
| N_RXD active (low) to stable RXD output | 16, 12 | | 25 | | ms | |
| *Signal applied with receiver enabled* | | | | | | |
| Signal to valid AF | 2, 11 | | 10 | | ms | |
| Signal to stable data | 2, 12 | | 25 | | ms | |

***Notes:***

1. Programs to any frequency in the 432 - 436MHz range (other frequencies by special order, subject to SAW filter availability). 458MHz and 448MHz band units also available
2. Measured into 50Ω resistive loads.
3. Exceeds EN/EMC requirements at all frequencies.
4. 2.5ppm TCXO. Total over full supply and temperature range.
5. With 0V – 3.0V modulation input.
6. To achieve specified FM deviation.
7. See applications information for further details.
8. For received signal with ±3kHz FM deviation.

## Channel Programming

At the heart of the device is a fractional N synthesizer locked to a high stability VCXO. The minimum step size of this PLL is (approximately) 12.4Hz

The data required by the PLL consists of two coefficients: the integer (INTE) and the fraction (FRAC). Output frequency relates to these values thus:

$$Freq = \left( INTE + \frac{FRAC}{2^{19}} \right) \times \frac{2 \times VCTCXO}{Outdiv} \qquad \text{where } \frac{2 \times 26MHz}{8} = 6.5MHz$$

NiM2B uses 26MHz VCTCXO and Output Divider (Outdiv) value for 425MHz - 525MHz band is 8.
For correct operation, the component (FRAC / $2^{19}$) must have a value between 1 and 2

$$Freq = \left( INTE + \frac{FRAC}{2^{19}} \right) \times 6.5 \qquad 1 \le \frac{FRAC}{2^{19}} \le 2 \qquad 524{,}288 \le FRAC \le 1{,}048{,}576$$

$$INTE = WholeNum\left[ \frac{Freq}{6.5} \right] - 1 \qquad FRAC = \left( DecimalNum\left[ \frac{Freq}{6.5} \right] + 1 \right) \times 524288$$

In interface terms, these coefficients are expressed as a 32-bit binary word (eight hexadecimal digits) where the most significant byte comprises the integer value, and the remaining three bytes (24 bits) make up "fraction"

**TX Example**: $\frac{434.650MHz}{6.5MHz} = 66.8692307692$

*INTE* = 66-1 = 65 (0x41)
*FRAC* = (0.8692307692 +1) × 524288 = 980015 (0x0EF42F)
FRAC2 = 0x0E
FRAC1 = 0xF4
FRAC0 = 0x2F

*Freq* = $\left( 65 + \frac{980015}{524288} \right) \times 6.5 = 434.649998MHz = 434.650MHz - 3.2Hz$

However, the frequency programmed into the receiver section is the LOCAL OSCILLATOR (LO) frequency, not the actual channel frequency.

For unit operating on a channel frequency of 446MHz or higher, the local oscillator is 21.4MHz below the carrier (so subtract 21.4MHz). AF output will be inverted on higher receive frequency units.

$$LO = RF - IF = 458.700MHz - 21.4MHz = 437.3MHz \quad \text{for } RF \geq 446MHz$$

For units operating on frequencies below 446MHz, the local oscillator is 21.4MHz above the channel.

$$LO = RF + IF = 434.650MHz + 21.4MHz = 456.05MHz \quad \text{for } RF < 446MHz$$

**RX Example**: $\dfrac{434.650MHz + 21.4MHz}{6.5MHz} = 70.1615384615$

*INTE* = 70-1 = 69 (0x45)
*FRAC* = (0.1615384615 +1) $\times$ 524288 = 608980 (0x094AD4) 0x094AD4
FRAC2 = 0x09
FRAC1 = 0x4A
FRAC0 = 0xD4

*Freq* = $\left(65 + \dfrac{608980}{524288}\right) \times 6.5 = 456.0499992MHz = 456.050MHz - 8.4Hz$

When programming the NiM2B, keep in mind that the unit maintains in SRAM the current values of all programmable values (frequency, band of operation, RF power and frequency offset adjustments values) and that toggling the PGM pin does NOT erase or corrupt them.

These values are only loaded from EEPROM at cold start power-up (but not when the relevant N_TXE or N_RXE pins are cycled)

There is one "write all values to EEPROM" command. It is usually necessary to load the relevant current operating RAM value(s) and THEN issue a suitable command to write the RAM value to EEPROM.

The NiM2B stores Frequency coefficients (for transmit and receive), frequency Offsets, band select and TX RF Power level constants in internal EPROMs.

**ALWAYS REMEMBER THAT THE TRANSMIT AND RECEIVE SECTIONS OF THE NiM2B ARE INDEPENDANT, AND ARE PROGRAMMED ENTIRELY SEPARATELY**.

No command sent to the transmitter will have any effect on the receiver, and vice-versa.

For the NiM2B RX section, power level should always be set to 3

Programming a value or coefficient over the serial bus over-writes the previous value and implements this change on the PLL immediately, but does not change the EEPROM contents until a relevant "program EEPROM" command is issued

In general, the most recent stimulus received by the unit will decide the operating frequency.
Whenever a frequency coefficient is programmed into the unit, the frequency will change immediately to this new value regardless of other modes or operation. This is the simplest and most flexible means of controlling the unit.

# Serial interface commands

NiM2B is programmable (in the same way as an NTX2B or NRX2B) using the N_Rxe or N_Txe pins
Reprogramming requires a 0v to +Vin logic level non-inverted RS232 data-stream to pin 3 (RX PGM) or 4 (TX PGM)
An RS232 port can be directly connected to the enable pin for programming.

The serial data should be in the following format: 9600bps, 8 data bits, No Parity, 1 Stop

Every command string starts with the phrase "@PRG_" and terminated with Carriage Return <cr>.

The characters in a command string must not be separated by more than 5ms (so typing individual characters on a terminal keyboard will NOT work), but a pause of at least 10ms is required between commands (more following a BURN_ROM command. In this case a much longer idle period, of 50mS at least, is needed for EEPROM programming)

### User commands

| Commands | Function |
|---|---|
| @PRG_iif2f1f0<cr> | sets the transmitter / receiver frequency<br>iif2f1f0 is an 8 digit hexadecimal number, coding 4 bytes:<br>ii is the "integer" value<br>f2 most significant FRAC2 byte in the 24 bit FRAC word<br>f1 bits 8 through 15 of the fraction word (FRAC1)<br>f0 least significant FRAC0 byte<br>e.g. @PRG_410EF42F<cr> to program 434.650MHz<br>(@PRG_45094AD4 <cr> for receiver) |
| @PRG_BURN_ROM<cr> | write current setup into EEPROM |
| @PRG_POWER 00<cr><br>@PRG_POWER FF<cr> | Turn the unit completely OFF (power down)<br>Turn the unit ON (power up)<br>TX /RX PGM pin can also be cycled |
| @PRG_00000000<cr> | Re-sets itself to the values currently stored in EEPROM<br>(this usually only happens at power-up) |

### Factory alignment commands

| Commands | Function |
|---|---|
| @PRG_POWER pp <cr> | Sets the RF Power output<br>pp is a 2 digit hexadecimal number (in the range 00 to 3F)<br>00 - power OFF, FF – power ON<br>e.g. @PRG_POWER 32<cr> |
| @PRG_TRIM+ aa <cr> | set an "up" offset<br>aa is 00 (0Hz) to 7F (+1574.8Hz) at 12.4Hz per bit<br>@PRG_TRIM+1E<cr> |
| @PRG_TRIM- aa <cr> | sets a "down" offset<br>aa is 00 (0Hz) to 7F (-1574.8Hz) at 12.4Hz per bit |
| @PRG_BAND# bb | band divider value (bb)<br>08 850-1050MHz<br>0A 425-520MHz<br>0B 280-350MHz<br>0D 140-175MHz<br>e.g. PRG_BAND# 0A<cr> |
| @PRG_BURN_ROM<cr> | write current setup into EEPROM |

# Applications information

### *Power supply requirements*

The NiM2B have built-in regulators which deliver a constant 3.0V to the transmitter and the receiver circuitry when the external supply voltage is 3.1V or greater. This ensures constant performance up to the maximum permitted rail, and removes the need for external supply decoupling except in cases where the supply rail is extremely poor (ripple/noise content >0.1$V_{p-p}$).

### *TX modulation requirements*

The module is factory-set to produce the specified FM deviation with a TXD input to pin 14 of 3V amplitude, i.e. 0V “low”, 3V “high

If the data input level is greater than 3V, a resistor must be added in series with the TXD input to limit the modulating input voltage to a maximum of around 3V on pin 14. TXD input resistance is 100kΩ to ground, giving typical required resistor values as follows:

| Vcc | Series resistor |
|---|---|
| ≤3V | - |
| 3.3V | 10 kΩ |
| 5V | 68kΩ |
| 9V | 220kΩ |

## *RX Received Signal Strength Indicator (RSSI)*

The NiM2B wide range RSSI which measures the strength of an incoming signal over a range of 60dB or more. This allows assessment of link quality and available margin and is useful when performing range tests.

The output on pin 11 of the module has a standing DC bias of up to 0.5V (approx.) with no signal, rising to around 2.0V at maximum indication. DVmin-max is typically 1V and is largely independent of standing bias variations. Output impedance is 56kΩ. Pin 11 can drive a 100μA meter directly, for simple monitoring.

Please note that the actual RSSI voltage at any given RF input level varies somewhat between units. The RSSI facility is intended as a relative indicator only - it is not designed to be, or suitable as, an accurate and repeatable measure of absolute signal level or transmitter-receiver distance.
Typical RSSI characteristic is as shown below:

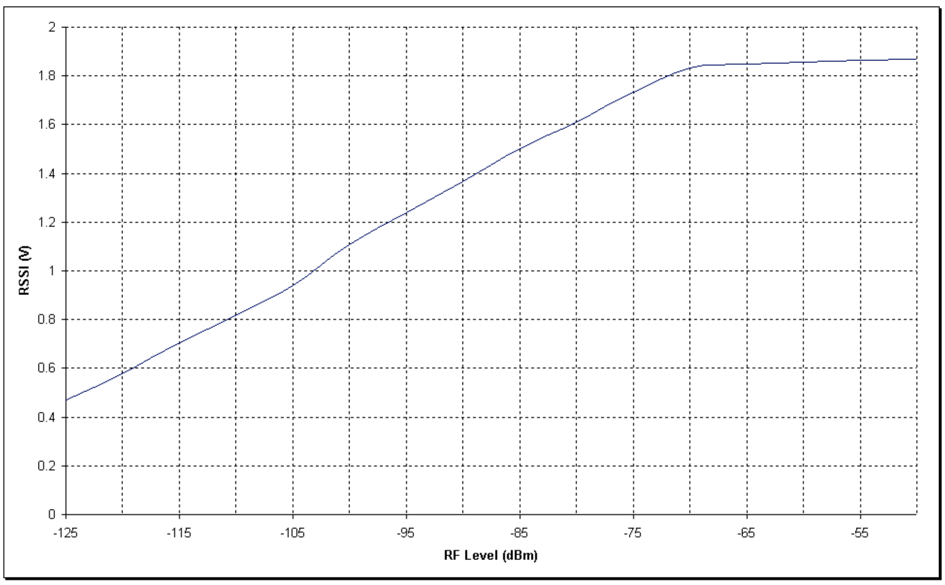


*Figure 4: RSSI level with respect to received RF level at NiM2B antenna pin*

### Expected range

Predicting the range obtainable in any given situation is notoriously difficult since there are many factors involved. The main ones to consider are as follows:

- Type and location of antennas in use
- Type of terrain and degree of obstruction of the link path
- Sources of interference affecting the receiver
- “Dead” spots caused by signal reflections from nearby conductive objects
- Data rate and degree of filtering employed

### Data formats and range extension

The NiM2B TXD input is normally driven directly by logic signals, but will also accept analogue drive (e.g. 2-tone signalling). In this case the TXD pin can either be directly DC driven with a 3v pp waveform with a 1.5v centre point, or a 3v pp signal can be AC coupled (when the input circuits will self-bias to 1.5v). Do not exceed 3v pp, or the baseband waveform will begin to clip.

The VC-TCXO in the NiM2B is highly linear, and tx distortion figures well under 5% should be seen. At the other end of the link the NiM2B AF output (or the RXD pin) may be used to drive an external decoder or other signal processing circuitry.

Although the modulation bandwidth of the NiM2B extends down to DC it is not advisable to use data containing a DC component. This is because frequency errors and drifts between the transmitter and receiver occur in normal operation, resulting in DC offset errors on the NiM2B audio output.

The NiM2B in standard form incorporates a low pass filter with a 5kHz nominal bandwidth. This is suitable for transmission of data at raw bit rates up to 10kbps.

## Antennas

The choice and positioning of transmitter and receiver antennas is of the utmost importance and is the single most significant factor in determining system range. The following notes are intended to assist the user in choosing the most effective antenna type for any given application.

*The following types of integral antenna are in common use:*

***Quarter-wave whip.*** This consists simply of a piece of wire or rod connected to the module at one end. At 434MHz the total length should be 164mm from module pin to antenna tip including any interconnecting wire or tracking. Because of the length of this antenna it is almost always external to the product casing.

***Helical.*** This is a more compact but slightly less effective antenna formed from a coil of wire. It is very efficient for its size, but because of its high Q it suffers badly from detuning caused by proximity to nearby conductive objects and needs to be carefully trimmed for best performance in a given situation. The size shown in figure 5 below is about the maximum commonly used at 433MHz and appropriate scaling of length, diameter and number of turns can make individual designs much smaller.

***Loop.*** A loop of PCB track having an inside area as large as possible (minimum about 4cm$^2$), tuned and matched with 2 or 4 capacitors. Loops are relatively inefficient but have good immunity to proximity detuning, so may be preferred in shorter range applications where high component packing density is necessary.

*Integral antenna summary:*

| Feature | whip | helical | loop |
|---|---|---|---|
| Ultimate performance | *** | ** | * |
| Ease of design set-up | *** | ** | * |
| Size | * | *** | ** |
| Immunity to proximity effects | ** | * | *** |

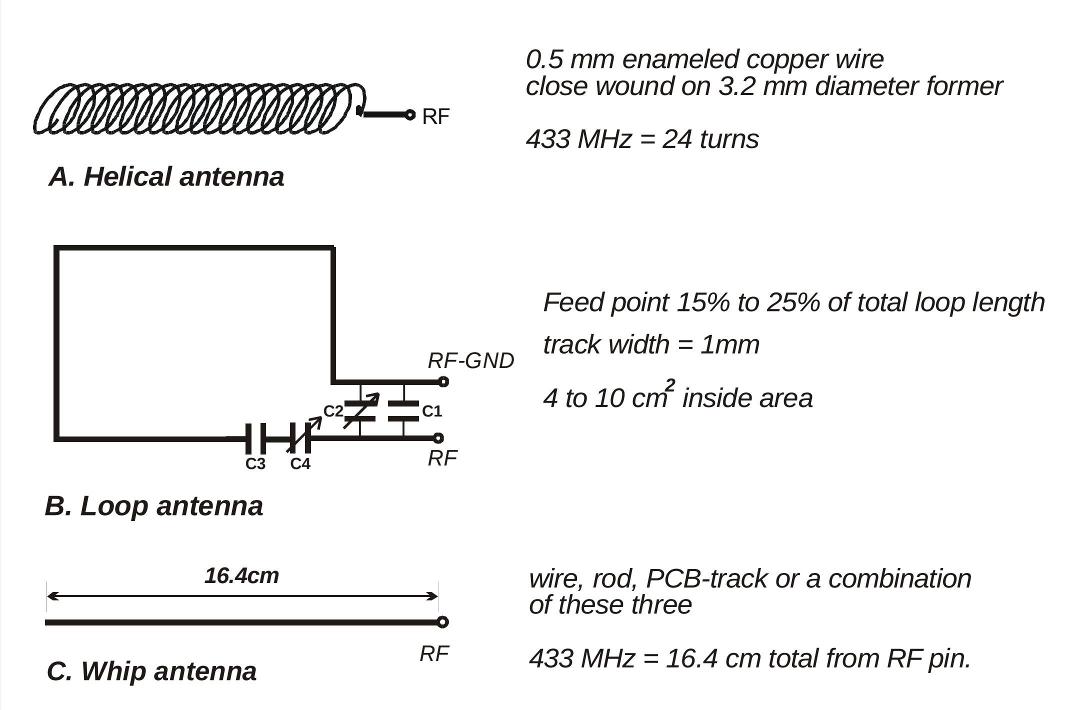


*Figure 5: integral antenna configurations*

***Module mounting considerations***

Good RF layout practice should be observed. If the connection between module and antenna is more than about 20mm long use 50Ω microstrip line or coax or a combination of both. It is desirable (but not essential) to fill all unused PCB area around the module with ground plane.

***Variants and ordering information***

The NiM2BT transmitters, NiM2BR receivers and NiM2B transceivers are manufactured in the following variants as standard:

| | | |
|---|---|---|
| *At 434.650MHz*: | NiM2B-434.65-10 | Transceiver |
| | NiM2BT-434.65-10 | Transmitter |
| | NiM2BR-434.65-10 | Receiver |

(These can be programmed on any frequency in the 432 - 436MHz range)

*458MHz and 448MHz band units are also available*
*Other frequencies are by special order, subject to SAW filter availability*

***NiM2B with separate TX and RX RF ports:*** NiM2B-434.65-10-TR

The NiM2B can be factory built with separate RX and TX ports.
This special built will have 4 pins on the RF connector instead of three (refer to figure 3)

Pin 1 RF GND
2 RF OUT (TX)
3 RF GND
4 RF IN (RX)

The RF IN (RX) port MUST be externally AC coupled, as it has a bias voltage on it

This is useful if an application requires using an external TX power amp, RX pre-amp, or separate antennas TX and RX.

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The Intrastat commodity code for all our modules is: 8542 6000

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After 7 April 2001 the manufacturer can only place finished product on the market under the provisions of the R&TTE Directive. Equipment within the scope of the R&TTE Directive may demonstrate compliance to the essential requirements specified in Article 3 of the Directive, as appropriate to the particular equipment.
Further details are available on The Office of Communications (Ofcom) web site:
***http://www.ofcom.org.uk/***

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